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Setting Space Transportation Policy for the 1990's

October 1986

In this study, Table 11, on page 39, should appear as attached.

The text referring to Table 11, on pages 38 and 39, should appear as below:

"If a new orbiter was flown four times each year and the marginal cost of a shuttle flight was \$65 million, then the real discounted cost of building and operating the additional orbiter at full capacity is estimated to be \$4.3 billion from 1987 through 2000. Expendable launch vehicles, each of which is capable of carrying only 40 percent of a shuttle flight and is launched at a cost of \$60 million, can provide comparable capacity at a cost of \$5.0 billion over the same period."

TABLE 11. THE DISCOUNTED COST OF SHUTTLE CAPACITY COMPARED WITH EQUIVALENT ELV PRODUCTION AT DIFFERENT ANNUAL FLIGHT RATES, 1987-2000
(In billions of 1986 dollars)

Annual Number of Equivalent Shuttle Flights	ELV	Shuttle
1	1.4	2.7
2	2.7	3.2
3	3.5	3.7
4	5.0	4.3

SOURCE: Congressional Budget Office.

NOTES: The estimates include: \$2.2 billion cost for a replacement orbiter with funding authorized from 1987 through 1992; a marginal operating cost of \$65 million per shuttle flight; a \$60 million launched cost for a .4 equivalent shuttle flight ELV at the three and four equivalent shuttle flight operating rate; a \$65 million launched cost for the same ELV at the two equivalent shuttle flights annual level; and \$70 million launched cost for the same ELV at the one shuttle flight operating rate.

See footnote 1 in this chapter for a definition of discounting.

**SETTING SPACE TRANSPORTATION
POLICY FOR THE 1990s**

The Congress of the United States
Congressional Budget Office



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PREFACE

The loss of the space shuttle Challenger has raised important issues in national space policy, including: should a replacement orbiter be purchased and, if so, how should it be financed; and what institutional arrangement should the United States adopt to participate in the international market for satellite launches? This special study, requested by the Senate Committee on Commerce, Science and Transportation, investigates these and other issues affecting the future U.S. role in space. In keeping with the Congressional mandate to provide objective nonpartisan analysis, the report makes no recommendations.

David H. Moore, of the Congressional Budget Office's (CBO) Natural Resources and Commerce Division, prepared the report, under the supervision of Everett M. Ehrlich. Mark R. Dayton, Paul DiNardo, and Lane Pierrot of CBO provided valuable comments and assistance. Many outsider reviewers, including individuals from the aerospace industry, made helpful comments and criticisms. Patricia H. Johnston edited the manuscript, and Kathryn Quattrone prepared the manuscript for publication.

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SUMMARY

The Challenger accident has catalyzed reconsideration of national space policy. Initial discussion centered on whether to replace the Challenger with another orbiter or with expendable launch vehicles (ELVs). But the accident soon focused the policy debate on underlying questions concerning the capacity of the shuttle system, the nation's future demand for launch services, the roles of the public and private sectors in meeting them, and the U.S. share of the worldwide commercial launch market. In addressing these space transportation issues, the Congress will also determine how quickly and to what extent the nation will realize the major objectives of the civilian space program: scientific exploration of space, provision of public services with satellites, encouragement of economic growth through private-sector use of space technology, and enhancement of national prestige.

The Administration recently proposed to replace the Challenger with a new orbiter, which would be funded, in large part, by reprogramming the future NASA budget. The Administration also proposed gradually removing the shuttle system and NASA from the launch market for commercial communication satellites, with the proviso that the shuttle would fly a portion of the existing 44 launch commitments. The purpose of the shift in commercial launchings is to allow the shuttle to serve the backlog of government cargos created by the accident and, simultaneously, to encourage U.S. private firms to offer ELV services to the commercial market.

The Congress also has initiated new actions. The Senate appropriations bill for fiscal year 1987 includes full funding for a new orbiter in the Department of Defense (DoD) budget rather than in the NASA budget. A bill presented to the Space Subcommittee of the House Science and Technology Committee (H.R. 5429) proposed that NASA procure 15 Delta rockets over five years to supplement the federal launch capacity.

U.S. LAUNCH SUPPLY, DEMAND, AND COSTS

The Administration proposed and the Congress approved new capacity for space transportation in a 1986 supplemental appropriation. The procure-

ment of Titan IV expendable launch vehicles was increased from 10 vehicles over five years to 23 over the same period. In addition, a new ELV program--the medium launch vehicle (MLV)--was approved and is scheduled to provide launches for four satellites annually beginning in 1989. As ELV production requires 24 to 36 months to bring new vehicles on line, and modification of the shuttle system will delay resumption of reasonable annual flight rates until 1989, the U.S. capacity to provide launch services is virtually nonexistent until that date.

Supply and Demand.

The Congressional Budget Office (CBO) estimates that in 1989 the U.S. launch systems--the three remaining orbiters, the Titan ELV production line and launch facilities, and the as yet undetermined MLV production line and launch facility--will provide a capacity to launch 21 to 24 shuttle flight equivalents annually.^{1/} This estimate serves as a starting point to evaluate whether additional new capacity--whether orbiter or ELV--is necessary to meet the nation's space transportation requirements.

Before the Challenger accident, the launch market traditionally served by U.S. capacity--national security, civilian government, and a major share of the free world's commercial demand--was projected in official estimates to require an annual average of 30 equivalent shuttle flights from 1986 through 2000 (without including those required for the deployment of a space-based defense system or extensive new space manufacturing). These projections envisaged rapid growth in the late 1980s, with a peak of 35 flights annually during the early 1990s when the U.S. space station was to be built. This level of activity would more than quadruple the annual average launch activity from 1970 through 1985. If realized, this high level of demand would justify added launch capacity, such as that provided by a fourth orbiter.

If the historical record is a guide, NASA, DoD, and NASA contractors have consistently overestimated launch demand. Moreover, the ramifications of the accident itself should lower launch requirements by raising the cost of space transportation and by making unanticipated demands on the NASA and DoD budgets. This analysis lowers the preaccident projections of

1. A shuttle equivalent is defined as an orbiter capable of carrying 65,000 pounds (lbs.), launched with a 50,000 lbs. load from the Kennedy Space Center to a low earth orbit of 28.5 degrees, 160 nautical miles above the Earth. This represents a load factor of slightly above 75 percent.

demand for 1986 through 2000 according to two other possible courses for demand. From NASA's estimate of an average of 30 shuttle flight equivalents per year, a **constrained version** of the official case sets an upper bound of 16.5 flights annually and a **historical case** projects a lower bound of 10.5 flights a year. This lower rate is based on extrapolating through the end of the century the demand over the last 15 years.

The resulting range of annual average demand--10.5 to 16.5 flights--could be served by CBO's estimated 1989 U.S. launch capacity (21 to 24 shuttle equivalents) without acquiring new launch capacity. The level of capacity estimated for 1989 ranges from 130 percent to 145 percent of projected annual demand in the constrained case and from 200 percent to 230 percent of the historical demand projection. The backlog of payloads accumulated while the shuttle is grounded, however, and the requirements of the space station, as currently planned, can be used to support arguments for procuring new capacity with a replacement orbiter or additional ELVs from existing facilities.

Costs

Before the loss of Challenger, the major issues of U.S. space transportation policy had been settled. The shuttle system was to be the primary mode of space transportation for all U.S. government payloads, because it was less costly and more capable than the older, expendable rocket technology that preceded it.

This report concludes that an additional orbiter should receive no significant cost advantage relative to expendable launch vehicles in deploying satellites. With the postaccident reduction in shuttle system capacity, shuttle costs are likely to increase, eliminating what was once a clear-cut cost advantage for additional orbiter capacity compared with ELVs. For example, between 1987 and 2000, the real discounted cost (at a 2 percent rate) of a new orbiter flown an average of three times each year is estimated to be \$3.7 billion, compared with the \$3.5 billion cost of comparable ELV services. If the orbiter is used more often, its cost-effectiveness improves relative to ELVs. An orbiter used an average of four times a year is estimated to cost \$4.3 billion, compared with \$5.0 billion for an equal ELV capacity. The demand projections developed in this analysis, however, suggest that an additional orbiter would actually experience lower demand and lower annual average flight rates. An orbiter flown only twice a year is estimated to cost up to \$500 million more than comparable ELV capacity. In the face of uncertain demand, ELVs could offer the advantage of a smaller initial funding commitment.

Both the options to replace the orbiter and to acquire additional ELVs offer certain noncost advantages. ELVs would not involve as great and direct a risk to human life as shuttle flights. An additional orbiter, as indicated, would be necessary to accomplish the construction phase of the space station as currently planned and would provide a degree of insurance in the event of unanticipated growth in demand or the loss of another orbiter. But most of the benefits of the shuttle's unique capabilities and, perhaps, a space station of different design could be realized by the existing three-orbiter fleet.

INSTITUTIONAL OPTIONS TO PROVIDE SPACE TRANSPORTATION FOR THE COMMERCIAL MARKET

Uncertainty concerning the capacity and capability of the shuttle system has prompted new interest in ELVs as an alternative to the shuttle in the commercial launch market. But it is not obvious who should build and operate these ELVs. Several institutional options are open to the United States in pursuing its goals for space transportation policy.

Preaccident policy for commercial space launches was strongly oriented towards shuttle technology, with NASA as the public-sector provider of U.S. launch capacity to the world market. Beginning in 1989, shuttle prices were to be established at a level approximating the long-run marginal cost of shuttle service. This price would have encouraged effective use of shuttle capacity and would have produced a surplus of current revenues over current costs, leading to a net contribution to the NASA budget. Since the federal government would incur the high fixed cost of operating the shuttle to meet federal needs whether the commercial market was served or not, pricing shuttle service to the commercial market at long-run marginal cost would allow the shuttle to capture at least 50 percent of the worldwide commercial market, without the need for government subsidies. In sum, in the preaccident environment, the United States was to become internationally competitive and economically efficient in providing space transportation, effectively using past federal investment in shuttle capacity while providing current budget support to NASA through sales to the commercial launch market.

The accident has negated this vision of the shuttle's future and its role in attaining U.S. space policy goals. The shuttle system's costs and capabilities now are uncertain; and its cargo, once flights resume in 1988, will be dominated by government payloads. Reflecting this change, the Administration has proposed commercializing U.S. ELVs by removing the federal government from the commercial market and by encouraging private enter-

prise to replace it. But questions can be raised about whether the ELV commercialization option would lead to an internationally competitive industry in the 1990s, and whether it would provide cost-effective use of federal space transportation capacity. The Congress may wish to consider two alternatives to ELV commercialization: allowing NASA to provide ELV services to the commercial market, and creating a mixed enterprise like Europe's Arianespace to bring an explicit public-sector/private-sector partnership into the commercial launch market. The ELV commercialization option and the two alternatives present both advantages and disadvantages when their implications are considered according to the following criteria:

- o The international competitiveness and economic efficiency of the U.S. launch presence in the commercial market;
- o The cost-effective use of federal space transportation capacity;
- o The future role of NASA and its budget; and
- o The administrative and legislative ease in implementing the chosen arrangement.

The **ELV commercialization option** would replace the government in the commercial market with U.S. private firms. These businesses would compete on the world market, initially with Arianespace, but later with other foreign entrants into the market. U.S. private firms would provide ELVs to their customers and launch them at rented government facilities. The NASA would continue to operate the shuttle and DoD would serve its own requirements with ELVs purchased from its budget. Either DoD or NASA, however, could purchase ELV services from the private sector. Direct federal acquisition of ELVs from potential private entrants is the most important federal influence on the international competitiveness of U.S. firms, since it would reduce the unit costs of ELVs through procurement of larger numbers.

The commitment of the DoD to purchase ELVs, the backlog of payloads created by the Challenger accident, and only limited foreign competition could characterize an environment through the early 1990s in which U.S. private firms could become internationally competitive and economically efficient. But after that time, the dissolution of the backlog and intensified (and perhaps subsidized) foreign competition could leave U.S. producers at a competitive disadvantage.